Gaia-FUN-SSO: a network for Solar System transient Objects

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Abstract: *During the Gaia mission, Solar System Object alerts will be triggered toward the ground. We have set up the Gaia-FUN-SSO network in order to coordinate fast reaction for the observation of these targets. In this article, we describe this network at the present stage, its recent activity for training campaigns of observation, and its next activity. We discuss also some points related to this organization and the strategy of observation.*

1. Introduction

Solar system objects will be observed by the Gaia probe during its five year mission. Among the daily flow of data, some of these objects will be not identified as known objects, or some detection of moving objects could be uncertain and will require confirmation. The Gaia-FUN-SSO network has been set up for being devoted to that kind of task through a follow-up of some critical Solar System Objects. Contrarily to other space missions, the possibility of such complementary ground-based observations for Solar System objects has been early identified during the preparation of the data processing. The triggering of alerts has been included in the process and the need of a dedicated ground-based network to deal with these alerts was foreseen since the beginning of the project. Another article (Carry et al., ibid.) gives information on the alert processing and on the tools for monitoring the network. In this article we describe the setting up of the network, its organization, and the activities already performed.

2. Gaia framework and goal

The main reason why during the Gaia mission we need a ground-based network for Solar System objects is the difficulty to monitor an object in space due to the observing mode of the probe. Gaia is not a space observatory which could point on demand but it is a scanning system. This observing mode will not allow to re-observe and confirm a newly detected moving objects. Only the ground-based follow-up network will allow this.

The Gaia data processing workflow includes an auxiliary orbital parameters data base which is used for identifying known Solar System objects during the operation and needs to be regularly updated. This update is due to the Minor PLanet Center collecting work and to the update of the Lowell database "astorb". In this context, the goal of our ground-based network is to detect from the ground the newly detected critical object after receiving an alert from the Gaia data processing system and to provide complementary astrometric measures. But these data will not be directly used by the Gaia data processing but indirectly. It will be sent by the observers to the Minor Planet Center in order to feed this international database of orbital elements. This will permit subsequently to update the auxiliary database of Gaia.

Despite preliminary analysis already done (Tanga et al. 2008, Bancelin et al 2012), it is still difficult to foresee the number of alerts that we will really get. During the first months of the mission several alerts, true or false alerts, could be triggered for validation of the detection of moving objects and will be useful for the tuning of the discrimination in the data processing system. During the main period of the mission, the alerts could concern mainly faint objects, NEAs, perhaps comets, close to magnitude 20, the limiting magnitude of Gaia. We are also awaiting detections at low Solar elongation since the zone at 45 degrees of elongation will be explored by the probe.

3. The Gaia-FUN-SSO network

The network has been developed on the basis of contacts with observers who are using instrumentation adapted to astrometric measurement on alert. The alerts must be triggered almost 48h after the detection. The minimum requirements are the following: to access the instrument in the nights following the alert; to perform short observing runs with CCD camera, pixel size of less than 1 arcsec; to use a field of view not too small (greater than 10 arcsec is useful in order to get reference stars); and to reach a limiting magnitude down to 20 similar to the Gaia limiting magnitude.

Fig. 1: Localization of the observing sites registered (in blue) in the Gaia-FUN-SSO network

At the date of this workshop, the Gaia-FUN-SSO network is composed of 39 observing sites rather well spread in longitudes (fig. 1). Obviously getting more observing sites in the south hemisphere, in Russia and in North America would be very useful. The observing sites have registered, giving the main parameters of their instrumentation: 55 telescopes are operating covering several classes of diameters from small robotic telescopes (Tarot telescopes with diameter 25cm) to the 2.4m telescope of the Chinese Lijiang observatory (fig. 2).

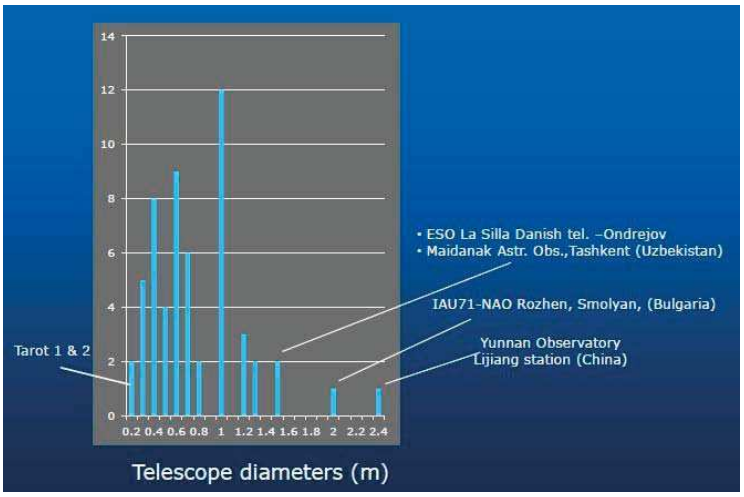

Fig. 2: Histogram of the telescope diameters involved in the Gaia-FUN-SSO network

4. Activity of the network

Since 2011, a wiki server is used for the coordination of the Gaia-FUN-SSO network. These pages, at the address https://www.imcce.fr/gaia-fun-sso/ give much information on the network, on the method for observing, on the tools well adapted and the useful links. Only the home page is public, registration is necessary to access to all this information. Registered observers can access to the ephemerides and the results of the campaign on this wiki.

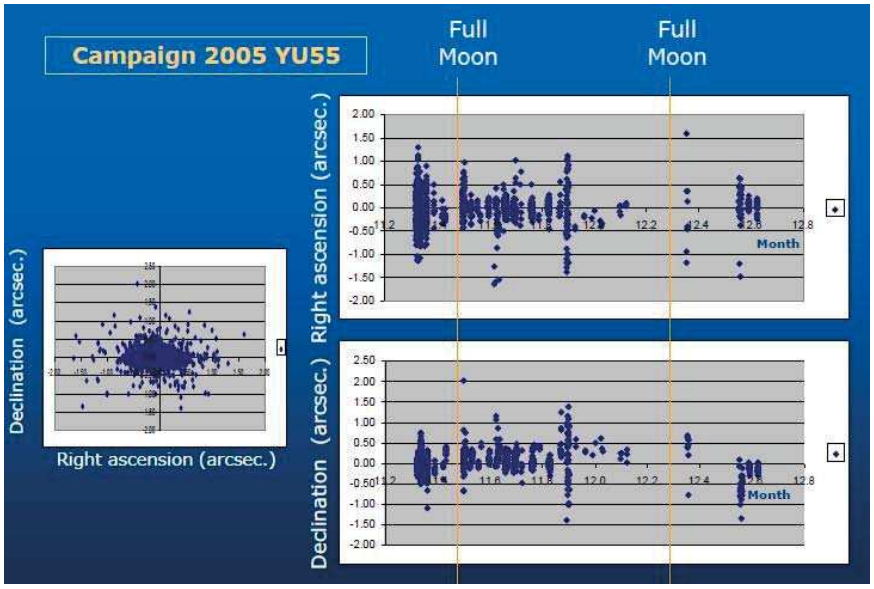

Fig. 3: Observed-Calculated (o-c) values obtained during the 2005 YU55 campaign in November-December 2011.

In this preliminary period, before the launch of Gaia in autumn 2013, several campaigns of observations were organized for the training of the observers and the testing of the network. The first one was organized in November 2011 (Todd et al. 2013), taking the opportunity of the close approach of the NEO 2005 YU55. 14 stations could participate (almost 40% of the network) and 1556 measures were obtained by the observers, leading to a fit of a dynamical model to the whole set of observations known (on 2187 days since the discovery) and a R.M.S. of 0.30 arcsec (fig. 3).

The second experiment was less successful by means of the number of observing stations, but was very successful as a real simulation of alert. On 17 January 2012, Th. Pauwels (Uccle, Royal Obs. Of Belgium, Brussels) detected an object, magnitude 20, at Solar elongation 133 degrees which will be a zone of observation of Gaia. An alert was triggered in the Gaia-FUN-SSO network, only 4 stations (MPC codes H15, A84, C20 and 461) could react, starting 1.4 day later. But the object (TP3522, renamed 2012 BS67) was successfully detected and followed.

We organized also a campaign for the observation of 99942 Apophis in March 2012 which was the first step of a longer campaign spanning up to March 2013. This asteroid is a famous PHA intensively studied since its discovery in 2004. Every new period of observation must not be lost and the Gaia-FUN-SSO network can give an important contribution. Further information will be provided at the end of this long campaign.

Conclusion

The Gaia mission will detect new Solar System Objects. Among them we will certainly have Near Earth Objects and in particular some with low Solar elongation or faint magnitude. Due to the observing mode of the probe, these objects could be lost. The ground-based follow-up network Gaia-FUN-SSO will have the goal to avoid that and to provide further observations in order to improve their ephemerides. This structure is well in shape but will be again improved in the next months in order to get the maximum efficiency for monitoring and automatization of the diffusion (see Carry et al, ibid.)

References

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